Standby power – a quiet use of energy

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Standby power is the energy consumed by appliances while switched off or not performing their primary task. About 5% of residential electricity – corresponding to 50 W/home – is now consumed by appliances in standby mode. International efforts to reduce this may lower standby power consumption in individual units, but the rising number of appliances used will probably cause a gradual increase in standby energy consumption.

Introduction

Standby power
The services provided by appliances are becoming increasingly diverse and sophisticated. Electronics play an ever-larger role in virtually all appliances, and units with rechargeable features are also becoming more common. Some of the most common appliances with standby power are televisions, cordless telephones, microwave ovens, and battery chargers. Every appliance with a remote control has standby power consumption.

The increased reliance on electronics has generally led to increased energy efficiency in providing these amenities. However, these same trends cause many appliances to continue to consume energy even while switched off or not performing their principal task. This phenomenon (which has acquired several names, including “standby power”, “standby losses”, “leaking electricity”, “waiting electricity”, “free-running power”, “off-mode power”, and “phantom loads”) has attracted worldwide attention because the aggregate energy use is already significant and appears to be growing rapidly. Standby power is an exciting area because it is closely associated with many of the newest technologies and trend-setting lifestyles.

What is standby power?
Experts still cannot agree on the definition of standby power. It is usually easy to identify as the energy used while the appliance is switched off. But the concept of “off” is becoming increasingly indistinct in some appliances. Video cassette recorders (VCRs), for example, keep track of the time, remember to record programmes at preset times, and sometimes even remember which channels have signals. Is the VCR “off” while doing all of this? Many people disagree. We like to think of standby power as “the minimum power consumption of an appliance while connected to the mains”. This definition covers most situations, but may not be precise enough for complex devices such as television set-top boxes.

Which appliances have standby power?
The number of appliances with standby power consumption is rapidly growing both in number and diversity. **Figure 1** shows appliances with standby mode in a typical US home.

It is sometimes difficult to decide if an appliance is consuming power while switched off because it has no lights or indicators. LBL has compiled guidelines to help identify appliances with standby where it is not possible to measure them. An appliance probably uses standby power if it has any of the following features, e.g.:

- it is powered from the mains through a stand-alone power supply;
- has a remote control;
- has a soft touch keypad;
- charges the battery of a portable device;
- is warm to the touch near the switch when switched off;
- does not have an “off” switch.

A brief inspection of any home (or office) will reveal many appliances meeting one or more of these criteria. The laboratory conducted an informal survey of homes in the United States and found that the average upper middle class house contained eight appliances with stand-alone power supplies. Many homes will have over 15 of these appliances.

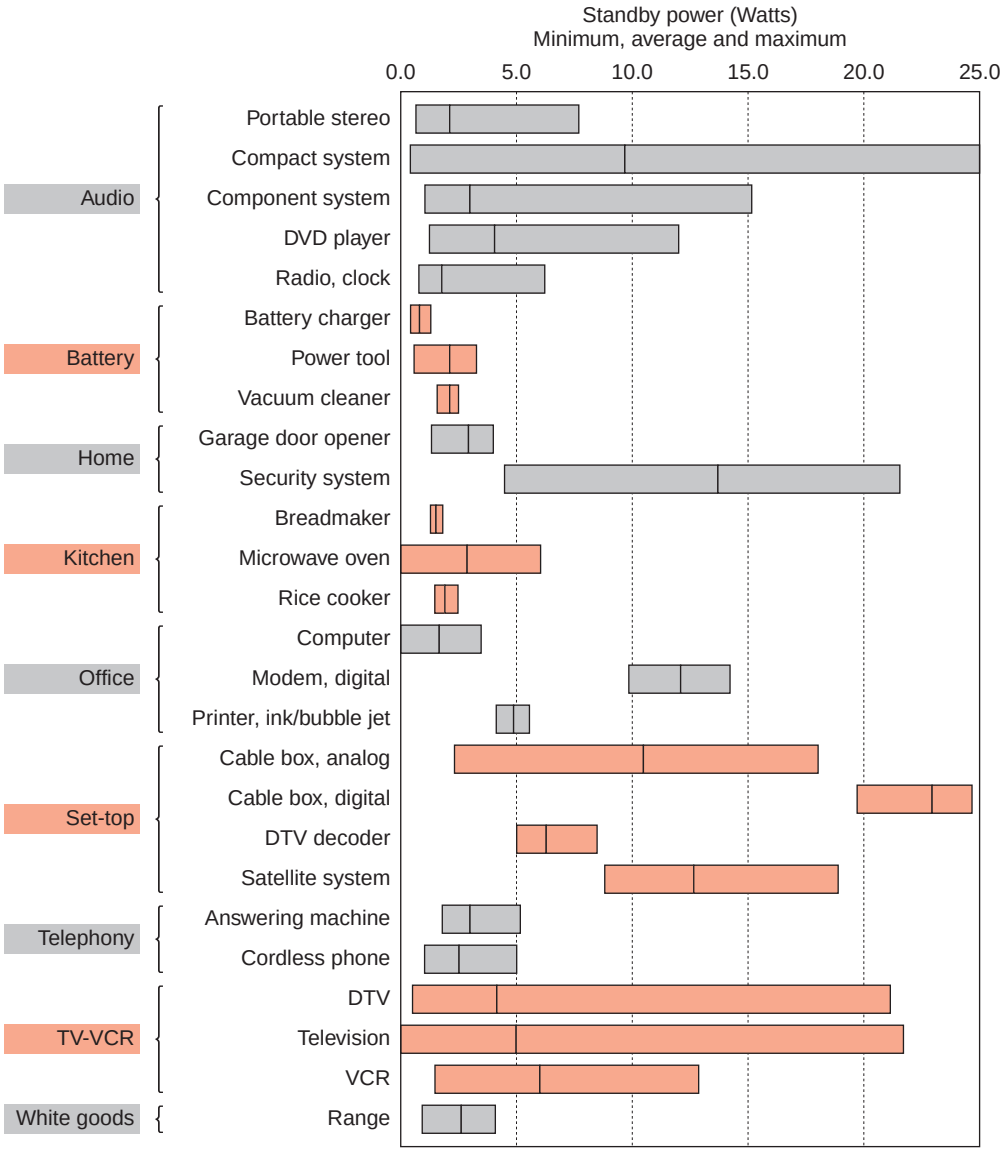
A large fraction of total standby power is lost by the transformer (or power supply) converting the electricity from the mains voltage to a lower voltage. Some power is converted to heat even when there is no load and further losses occur when supplying the small amount of power needed for standby operations. The remaining power is used for microprocessors, sensors and displays. Many of these components require only a few mW of power for

operation, even though the appliance will be drawing several thousand while in standby mode.

Individual standby measurements
LBL (and our colleagues around the world) have measured standby power use in hundreds of appliances.
A partial listing is shown in **Figure 1**, giving the minimum, average and maximum values for each appliance.

Once again, the number of appliances with standby is impressive, but it is also surprising to see the range of standby power for a single type of appliance. For example, compact audio systems have standby varying from 1.3 W to 28.6 W. Some of this is accounted for by differences in features; e.g. certain audio equipment has larger and brighter displays than others. But most of the variation arises from differences in design and choice of components, resulting in some units consuming four times as much power to provide the same services.

Figure 1: Measurements of standby power for appliances in a typical US home.



Certain appliances also consume nearly as much power while switched off as when they are switched on. Most television set-top boxes (also called "cable boxes") show almost no change in power consumption between the two modes (see **Table 1)**. Several models of compact audio equipment and VCRs have similar "on" and "off" power.

Some "white goods" (refrigerators, washing machines, dishwashers, etc.) are just beginning to have standby power use because manufacturers are installing microprocessors to control appliance operation. This trend is most advanced in Japan, where nearly all white goods now have these features. The United States and Europe are further behind but clearly following the Japanese trend. Manufacturers are now advertising prototype appliances with "connectivity", where each appliance has its own Internet IP address and thus can be controlled remotely. This feature will also require standby power.

Larger implications of standby

The standby power use by an individual appliance is typically very small – not more than a few watts – but standby is significant because it means continuous consumption and because so many appliances exhibit this behaviour. In order to grasp the larger implications of standby, LBL estimated energy consumption from standby in the average US home and for the country as a whole.

In the home
The average home's standby use was estimated by calculating the types and number of appliances with standby in an average home, then adding up the standby power of all the devices. The average US home uses around 50 W of standby power, which corresponds to 5% of the home's total electricity bill.

Similar studies in Japan and Europe revealed surprisingly similar results. Japanese homes have about the same amount of standby (because they have more appliances with electronics) but these represent a higher fraction of total electricity use, some 10-15%. European homes have slightly fewer appliances than Japanese and American homes, so standby is a slightly less. Nevertheless, standby is a significant amount in all developed countries.

In the United States

There are over 100 million homes in the United States, so standby power consumes roughly 5 GW. After accounting for transmission and distribution losses and generation reserves, standby is responsible for about 8 GW. This corresponds to the output of eight large power plants. The true consumption is probably closer to twice this, because the commercial and industrial sectors also have equal amounts of equipment with standby mode.

Technologies to reduce standby

It is technically feasible to greatly reduce standby power in most appliances. Such reductions require a combination of strategies, some of which have only recently become commercially available.

The greatest improvements are likely to occur in the power supplies. Recent innovations, notably "switch-mode" technologies, have cut no-load losses to as little as 0.25 W and maintain very high conversion efficiencies at low power.

Recent advances in light emitting diodes (LEDs) have also made bright, colourful and low-power displays technically feasible. Other low-power displays are also appearing. Another major cause of standby power consumption, the microprocessor, can also be operated more efficiently.

Table 1: Measured power consumption of various set-top boxes while on and off (Watts).

Power use	Cable boxes	Internet terminals	Satellite receivers	Video games
On	12.4	13.8	12.9	8.8
Off	11.4	10.6	12.3	1.0

Microprocessors still consume several watts, but many of them have power management modes that permit, among other things, drastic reductions in cycle frequency.

It is technically feasible to reduce standby in most cases to below 1 W per appliance. This corresponds to roughly a two-thirds reduction in today's typical appliance. A target of 1 W may not yet be economic in all situations today, but the trend is moving in that direction. Some appliances, such as certain cellphone chargers, have already fallen below 0.5 W. Manufacturers are using new technologies primarily to reduce the size of the charging units rather than save energy, so the extra cost may not justify the energy savings.

The future of standby

Several countries have initiated programmes to reduce standby power consumption in televisions, VCRs, and audio equipment. In the United States, the Energy Star label on consumer electronics identifies those with low standby power use. New consumer electronics are now appearing with much lower standby thanks in part to these programmes. However, an increasing number of appliances will have standby power use. White goods, for example, are only just beginning this transformation. If no special measures are undertaken the net result will probably be a gradual increase in standby power.

Internet information sources:
http://eetd.lbl.gov/standby/
http://www.epa.gov/energystar/
http://www.iea.org/standby/

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